NASA Space Radiation Program
INTERAGENCY COLLABORATION

Walter Schimmerling

Management of space radiation risk is a collaborative endeavor requiring the participation of international as well as national radiation research organizations. The following is a partial summary of the multifaceted interactions between NASA and selected other organizations in the first 15 years since establishment of the program in 1990. Descriptions of organizations not mentioned here are encouraged and will be added as they become available.

The agencies with which the NASA Space Radiation Program had the most significant programmatic interactions were, in the United States, the Department of Energy and the National Cancer Institute, with significant contributions from the Armed Forces Radiobiology Research Laboratory (AFRRI) of the Department of Defense. At the international level, the program sponsored a joint Specialized Center for Research and Training (SCORT) together with the German space agency (at the time, DARA). The program also participated in joint efforts with other spacefaring nations, not detailed here, and initiated the ongoing series of biannual international conferences on space radiation research. Within NASA, the program interacts strongly with other organizations, delivering requirements as well as receiving critical information on the radiation environment in real time from the National Oceanic and Atmospheric Administration.

One of the earliest interagency organizations attempting to share information among government agencies was the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC). CIRRPC was chartered April 9, 1984 under the Federal Coordinating Council for Science, Engineering and Technology (FCCSET), reporting to the Office of Science and Technology Policy (OSTP), Executive Office of the President. Its overall charge was to coordinate radiation matters between agencies,evaluate radiation research, and provide advice on the formulation of radiation policy. Radiation-related issues under its purview included federal radiation policy, regulations and standards, radiation compensation, radon, non-ionizing radiation, high-let radiation, radiation measurements, records and control, public information and education, emergency preparedness and cleanup standards, food irradiation, and radioactive wastes. Many of these issue continue to be of importance for interagency coordination; howver,CIRRPC was disbanded in the early 1990s.

The NASA/DARA SCORT (1993-1995) was establishd by a Letter of Agreement signed by J. Vernikos (NASA) and G. Gertzen at Joint NASA/DARA/DLR Working Group meeting, Potsdam, Germany (23 September 1993). Its Director was Professor J. Kiefer, University of Gießen. During its lifetime, this Center had a fruitful

collaboration with the original NSCORT established at the Lawrence Berkeley National Laboratory, directed by A. Chatterjee.

In 1994, NASA signed a Memorandum of Agreement with Loma Linda University Medical Center, with main articles specifying that:

- Loma Linda University is a health sciences institution with Schools of Medicine, Nursing Public Health, Allied Health, and graduate school programs. Loma Linda University Medical School is a teaching hospital serving over 500,000 patients annually. Loma Linda University Medical Center (LLUMC), affiliated with the Medical School, has recently commissioned a modern proton synchrotron with proton beams of energies between 70 and 250 MeV for radiation treatment of cancer.

- NASA participation in the activities envisioned by this MOA is strictly limited to basic science not involving human subjects. Information will be shared between NASA non-human basic research and Loma Linda cancer therapy programs.

- NASA-sponsored scientists will contribute to the education and training of the Loma Linda medical community by means of seminars, lectures, opportunities to participate in NASA basic research teams, and other appropriate academic activities.

- Signed on Thursday, December 1, 1994.

Collaboration between NASA and the National Cancer Institute (NCI) was implemented in two phases. During the years 1992 to 1995 it was governed by a Memorandum Of Understanding establishing formal scientific collaboration with goals stated as:

(1) to enhance basic knowledge of living systems and their responses to radiation exposure;
(2) to apply this knowledge to radiation protection, risk assessment, diagnosis, and treatment of cancer; and,
(3) to exchange technology.

During this phase, joint NASA/NCI funding was provided for approximately half a dozen projects at a level of $200 - $300K, supporting research in cellular radiobiology on mutagenesis, repair, carcinogenesis as well as less specific collaborative efforts in medical diagnostic imaging and technology transfer.

The second phase of NASA/NCI collaboration occurred during the years 1995 to 2002, following signing of a Memorandum of Agreement on July 1, 1994. The agencies sponsored a joint Request for Applications (RFA), with a planned funding level of approximately $2M per year for 5 years, to study Mechanisms of Genomic

Instability from the Exposure of Mammalian Cells to High-Let Ionizing Radiations. The background given for this joint effort was:

- high-LET-induces GI long-term accumulation of genetic abnormalities (e.g., chromosomal aberrations) among progeny of irradiated cells,
- a sizable fraction of mammalian cells that survive exposure to high-LET radiation can transmit the GI phenotype to their progeny,
- high-LET is more potent than are low-LET gamma and x rays,
- long-term expression of high-LET-induced GI may result in elevated rates of mutagenesis and neoplastic transformation.

The following steps ultimately led to funding of 9 research proposals :

August 3-4, 1995: workshop on "Mechanisms of Transmissible Genomic Instability (TGI) from the Exposure of Mammalian Cells to Ionizing Radiation" provided prioritized recommendations on research into radiation-induced TGI,

October 5-6, 1995: presentation to NCI Board of Scientific Councilors,

Letter of Intent Receipt Date: April 24, 1996,

Application Receipt Date: June 14, 1996,

Peer review and reconciliation of NASA/NCI selections,

Award Date: April 1, 1997.

Collaboration between NASA and the Department of Energy (DOE) traces its roots to many years of NASA support for researchers at the Princeton Particle Accelerator (PPA) and the Lawrence Berkeley National Laboratory (LBNL), including some of the initial observation of light flashes produced by HZE particles. Subsequent to the closing of the LBNL Bevalac accelerator, NASA and DOE signed significant agreements to ensure that beams of high energy heavy ions continued to be available to simulate space radiation for physics and radiobiology research.

Agreements between NASA and DOE related to the use of BNL accelerators were made with the DOE offices overseeing use of the nuclear and high energy physics facilities. A Memorandum of Understanding was signed with DOE on July 9, 1992, followed by agreements with Brookhaven National Laboratory (BNL) on April 13, 1994 and an Implementation Agreement with BNL on October 29, 1997.

The 1994 Memorandum of Agreement with BNL specified as its goals:

(1) to implement the use of BNL accelerator facilities, such as the Alternating Gradient Synchrotron (AGS) to simulate components of the space radiation environment ;
(2) to support scientific investigations intended to acquire basic knowledge of living systems and their response to radiation exposure in space;
(3) to promote science and technology developments, based on BNL capabilities, that meet NASA requirements for radiation protection in space;
(4) In conformity with the Memorandum of Understanding (MOU) between NASA and the Department of Energy (DOE), signed on July 9, 1992.

The 1997 Implementation Agreement addressed construction of the NASA Space Radiation Laboratory, initially referred to as the "Booster Accelerator Facility" (BAF). It describes the following responsibilities for the partners:

JOINT RESPONSIBILITIES:

- develop funding plan for construction of BAF.
- assure that activities conducted at BNL conform to Safety, Health and Environment standards.
- use DOE cost methodology for budgets.

RESPONSIBILITIES of NASA:

- provides scientific oversight of the research program.
- provides representatives to a joint DOE-NASA technical and budget review of BAF.
- pays for Environmental Assessment and penetration of the Booster tunnel.
- pays for the incremental costs of the AGS, and the BAF when completed.
- participates in joint activities with BNL.

RESPONSIBILITIES of DOE:

- makes available beams and the use of BNL facilities and staff.
- ensures cost-effectiveness and meets NASA's requirements.
- submits a detailed proposal for construction and operation of BAF.
- in cooperation with NASA, conducts a Technical, Cost, Schedule and Management review of the proposed BAF.
- monitors and reviews the status of the project after start of construction.

This agreement was signed by A. Nicogossian for NASA and M. Krebs for DOE. The BNL budget was augmented by $300K to initiate construction, and tunnel penetration was achieved in February 1997. DOE issued "Finding of No Significant Impact (FONSI)" for Environmental Assessment (July 1998) and NSRL was completed on

schedule and within budget and commissioned in 2003.

NASA/DOE joint research sponsorship started in 2002 and continues as detailed elsewhere. On January 10, 2002 a Memorandum of Agreement (MOA) was signed between the Office of Biological and Environmental Research (OBER) and NASA's Office of Biological and Physical Research, establishing "formal scientific collaboration in understanding and predicting the effects and health risks resulting from low-dose and low-fluence radiation." A Joint Research Solicitation was issued February 15, 2002 with NASA contributing $0.5M in FY02, and $1M per year subsequently. Areas of particular programmatic interest were declared to be: relation between endogenous oxidative damage and low dose radiation-induced damage, radioadaptive responses, bystander effects, individual genetic susceptibility to low dose radiation, and extensions to space radiation using accelerator beams. Subsequent to peer review by DOE on June 4-6, 2002; NASA selected 6 of 17 approved proposals for joint (supplemental) funding.